

1 **PROCESS FOR REDUCING THE POUR POINT AND VISCOSITY**
2 **OF FISCHER-TROPSCH WAX**

3
4 FIELD OF THE INVENTION

5
6 The present invention is directed to a process for lowering the pour point and
7 viscosity of a Fischer-Tropsch wax to facilitate its handling and shipping.
8

9 BACKGROUND OF THE INVENTION

10
11 The Fischer-Tropsch process is useful for converting stranded natural gas into
12 higher molecular weight hydrocarbons. In remote locations, there is often no
13 economically attractive way to transport the natural gas produced at the
14 wellhead to market. Previously, stranded natural gas produced in remote oil
15 fields was either re-injected into the well or flared. Neither method of
16 disposing of the natural gas was satisfactory from either an environmental or
17 an economic perspective. However, by operating a Fischer-Tropsch unit at
18 the production site, the methane and normally gaseous hydrocarbons, such
19 as ethane, propane and butane, may be converted into C₅ plus hydrocarbons
20 which may be more readily transported as liquids. Unfortunately, a high
21 molecular weight waxy fraction is also produced which presents its own
22 handling problems.
23

24 The hydrocarbons recovered from the Fischer-Tropsch synthesis reactor
25 usually may be classified into three categories based upon a combination of
26 their molecular weight and boiling point. The lowest molecular weight fraction
27 is normally gaseous at ambient temperature and is also the least valuable
28 commercially. Parts of this gaseous fraction may be used locally as fuel, sold
29 as LPG, upgraded by oligomerization to higher molecular weight material, or
30 recycled to the Fischer-Tropsch synthesis unit. The Fischer-Tropsch
31 condensate fraction which usually has a boiling range between about ambient
32 temperature and about 650 degrees F is normally liquid at ambient

1 temperature and may be readily transported by ship to a refinery where it may
2 serve as a feedstock for upgrading to transportation fuels, such as naphtha,
3 jet and diesel, or used as a feedstock in petrochemical processes, such as
4 ethylene cracking. The Fischer-Tropsch wax fraction is generally a solid at
5 ambient temperature, and, like the condensate, the wax must be further
6 processed in a refinery before it yields commercially valuable products.
7 Unfortunately, the solid wax cannot be pumped at ambient temperatures and
8 consequently is not readily transportable by ship. Therefore, the
9 Fischer-Tropsch wax presents its own handling and transportation problems.
10 See U.S. Patent No. 6,518,321.

11

12 Various methods for processing the Fischer-Tropsch wax prior to transporting
13 it have been proposed. See, for example, U.S. Patent Nos. 6,268,401
14 and 6,294,587. Thermal cracking has been proposed for use in lowering
15 the pour point both of conventional petroleum derived waxy crude
16 (U.S. Patent No. 6,337,011) and of Fischer-Tropsch waxes
17 (PCT Publication WO 99/37737). U.S. Patent No. 6,379,534 describes a
18 process for lowering the pour point of waxy petroleum derived crude by first
19 separating the waxy crude into its high boiling and low boiling components
20 and then using a combination of thermal cracking of some of the higher
21 boiling hydrocarbons followed by blending back of some lower boiling
22 hydrocarbons to produce a lower pour point crude.

23

24 Ideally, a process for preparing the Fischer-Tropsch wax at a remote location
25 prior to shipment will (a) produce a liquid product which is pumpable at mild
26 temperature, (b) use relatively simple equipment, (c) be easy to operate, and
27 (d) require relatively low capital and operating costs. None of the prior
28 processes for handling Fischer-Tropsch wax meet all of these criteria. The
29 process of the present invention does. In addition, the process of the present
30 invention may be integrated with the operation of the Fischer-Tropsch unit to
31 increase the yield of desirable products and reduce the operating expenses.

1 In paraffinic base residua derived from conventional petroleum, long paraffinic
2 chains attached to aromatic rings are believed to be the primary cause of high
3 pour points and viscosities. Therefore, visbreaking when used with
4 conventional petroleum derived crude is carried out under conditions to
5 optimize the breaking off of these long side chains and their subsequent
6 cracking to shorter molecules with lower viscosities and pour points. See
7 *Petroleum Refining: Technology and Economics* by James H. Gary and
8 Glenn E. Handwerk (Chapter 5, pages 84-85) 4th Ed., Marcel Dekker N.Y.
9 (2001). Fischer-Tropsch derived hydrocarbons are mainly normal paraffins
10 and, unlike petroleum derived crude, do not contain aromatics. Therefore, it is
11 particularly surprising that mild thermal cracking of Fischer-Tropsch derived
12 materials results in significant large pour point reduction.

13
14 As used in this disclosure, the words "comprises" or "comprising" are intended
15 as an open-ended transition meaning the inclusion of the named elements,
16 but not necessarily excluding other unnamed elements. The phrases
17 "consists essentially of" or "consisting essentially of" are intended to mean the
18 exclusion of other elements of any essential significance to the composition.
19 The phrases "consisting of" or "consists of" are intended as a transition
20 meaning the exclusion of all but the recited elements with the exception of
21 only minor traces of impurities.

22 SUMMARY OF THE INVENTION

23
24
25 In its broadest aspect, the present invention is directed to a process for
26 lowering the pour point of Fischer-Tropsch derived wax which comprises
27 (a) collecting separately from a Fischer-Tropsch unit a Fischer-Tropsch wax
28 and a Fischer-Tropsch condensate; (b) pyrolyzing the Fischer-Tropsch wax in
29 a thermal cracking zone under thermal cracking conditions pre-selected to
30 achieve a cracking conversion of the paraffin molecules present in the
31 Fischer-Tropsch wax of at least 10 percent; (c) recovering from the thermal
32 cracking zone a thermally cracked Fischer-Tropsch derived wax intermediate

1 having a lower pour point than the Fischer-Tropsch wax; and (d) mixing at
2 least a portion of the Fischer-Tropsch condensate collected in step (a) with at
3 least a portion of the thermally cracked Fischer-Tropsch derived wax
4 intermediate in the proper proportion to produce a Fischer-Tropsch derived
5 waxy product having a pour point equal to or below about 40 degrees C.
6 The present invention is also directed to an integrated process for lowering
7 the pour point of Fischer-Tropsch derived wax which comprises (a) collecting
8 separately from a Fischer-Tropsch unit a Fischer-Tropsch wax and a
9 Fischer-Tropsch condensate; (b) pyrolyzing the Fischer-Tropsch wax in a
10 thermal cracking zone under thermal cracking conditions pre-selected to
11 achieve a cracking conversion of the paraffins molecules present in the
12 Fischer-Tropsch wax of at least 10 percent; (c) recovering from the thermal
13 cracking zone a low pour point Fischer-Tropsch derived wax and a
14 Fischer-Tropsch derived overhead product; and (d) mixing at least a portion of
15 the Fischer-Tropsch derived overhead product recovered in step (c) and at
16 least a portion of the Fischer-Tropsch condensate collected in step (a) with at
17 least a portion of the low pour point Fischer-Tropsch derived wax in the proper
18 proportion to produce a Fischer-Tropsch derived waxy product having a pour
19 point equal to or below about 40 degrees C.

20
21 In addition to lowering the pour point of the Fischer-Tropsch derived waxy
22 product, the present invention will also reduce the viscosity.

23
24 As will be discussed in greater detail below, in the integrated process, the
25 Fischer-Tropsch derived overhead product recovered from the thermal
26 cracking zone comprises Fischer-Tropsch derived hydrocarbons having a
27 lower boiling range than the low pour point Fischer-Tropsch derived wax.
28 Generally, the Fischer-Tropsch derived overhead product will contain a
29 mixture of C₅ plus hydrocarbons, i.e., hydrocarbons which are normally liquid
30 at ambient temperature, such as, for example, pentane, hexane and heptane;
31 and C₄ minus hydrocarbons, i.e., hydrocarbons which are normally gaseous at
32 ambient temperature, such as, for example, ethane, propane and butane. In

1 addition, depending upon how severe the thermal cracking reactor is
2 operated, the Fischer-Tropsch derived overhead product may also contain a
3 significant amount of methane. Generally, it is advantageous to separate the
4 C₄ minus hydrocarbons from the C₅ plus hydrocarbons. A C₁₋₂ fraction can be
5 isolated and recycled upstream of the syngas generation process, recycled to
6 the Fischer-Tropsch unit, flared, used to produce hydrogen, and/or used for
7 fuel. A C₃₋₄ fraction can be recycled upstream of the syngas generation
8 process, recycled to the Fischer-Tropsch unit, flared, used for fuel,
9 transported in pressurized tankers, and/or transported in refrigerated tankers.

10
11 As used in this disclosure, the phrase "Fischer-Tropsch derived" refers to a
12 hydrocarbon stream in which a substantial portion, except for added
13 hydrogen, is derived from a Fischer-Tropsch process regardless of
14 subsequent processing steps. Accordingly, a "Fischer-Tropsch derived liquid
15 waxy product" refers to a highly paraffinic product which comprises a
16 substantial portion of hydrocarbons boiling above about 700 degrees F that
17 was initially derived from the Fischer-Tropsch process.

18 19 BRIEF DESCRIPTION OF THE DRAWING

20
21 The Figure is a diagram which illustrates an embodiment in which the process
22 of the present invention is integrated with a Fischer-Tropsch unit.

23 24 DETAILED DESCRIPTION OF THE INVENTION

25
26 The invention will be more clearly understood by reference to the Figure
27 which illustrates an embodiment in which the process of the invention is fully
28 integrated into a Fischer-Tropsch synthesis operation. Methane recovered
29 from the wellhead gas is carried by line 2 to an autothermal reforming unit 4
30 where the methane is converted into syngas which comprises primarily a
31 mixture of hydrogen and carbon monoxide. The syngas passes from the
32 autothermal reforming unit by line 6 to the Fischer-Tropsch reactor 8. In the

1 Fischer-Tropsch reactor, the syngas is converted into a mixture of
2 hydrocarbons containing anywhere from 1 to 200 plus carbon atoms with the
3 majority falling within the C_5 to C_{100} plus range. As noted previously, the
4 products from the Fischer-Tropsch synthesis may be classified into three
5 categories. One fraction which is normally gaseous at ambient temperature
6 comprises primarily methane and hydrocarbons containing between 2 and
7 about 4 carbon atoms. Although not shown in the Figure, these lower
8 molecular weight hydrocarbons may be recovered. A C_{1-2} fraction can be
9 isolated and recycled upstream of the syngas generation process, recycled to
10 the Fischer-Tropsch unit, flared, used to produce hydrogen, and/or used for
11 fuel. A C_{3-4} fraction can be recycled upstream of the syngas generation
12 process, recycled to the Fischer-Tropsch unit, flared, used for fuel,
13 transported in pressurized tankers, and/or transported in refrigerated tankers.
14 The hydrocarbon fraction containing between about 5 to about 19 carbon
15 atoms is normally liquid at ambient temperature and is referred to in this
16 disclosure as condensate. The condensate is shown in the Figure as being
17 collected from the Fischer-Tropsch reactor by line 10. The C_{20} plus fraction
18 referred to as Fischer-Tropsch wax is shown being collected from the
19 Fischer-Tropsch reactor by line 12 which carries the fraction to a heat
20 exchanger 14 where the temperature of the wax is raised. From the heat
21 exchanger, the Fischer-Tropsch wax is transported by line 16 to the thermal
22 cracking unit 18.
23
24 In the thermal cracking unit 18, the Fischer-Tropsch wax is subjected to mild
25 thermal cracking sufficient to significantly reduce the pour point of the wax.
26 The low pour point wax is collected in line 20 which carries it to a fractionation
27 column 22 where any C_4 minus gases are collected as overhead gases in
28 line 24. Hydrocarbons containing from about 5 to about 19 carbon atoms,
29 i.e., normally liquid at ambient temperature, are collected from the
30 fractionation column in line 26. The low pour point wax is shown being
31 collected from the bottom of the fractionation column by line 28 and being split
32 into two streams. One low pour point wax stream is carried by line 30 to heat

1 exchanger 14 where it is used to preheat the Fischer-Tropsch wax going to
2 the thermal cracking unit 18. After passing through the heat exchanger, the
3 cooled low pour point wax stream passes by line 31 back to line 20 to quench
4 the thermal cracking reactions. The second low pour point wax stream is
5 carried by line 32 to be mixed with the C₅ to C₁₉ hydrocarbons in line 26 and
6 the condensate in line 10. The three components are mixed in the proper
7 proportions in line 26 to produce a low pour point waxy product which is liquid
8 at ambient temperature and readily handled by conventional pumping
9 equipment normally available at petroleum loading and unloading facilities.
10 It will be seen that, in this embodiment, the low pour point waxy product
11 formed is a mixture of the low pour point wax, the C₅ to C₁₉ hydrocarbons
12 collected from the thermal cracking unit, and the condensate recovered
13 directly from the Fischer-Tropsch reactor.

14

15 Hydrocarbons containing less than 5 carbon atoms are collected from the
16 fractionation column 22 as overhead gases by line 24. The overhead gases
17 are sent to a separator 34 in which the methane is separated from the
18 C₂ to C₅ hydrocarbons. A C₁₋₂ fraction can be recycled upstream of the syngas
19 generation process by line 36, recycled to the Fischer-Tropsch unit by line 38,
20 or, alternatively, via line 39 it may be flared, used to produce hydrogen,
21 and/or used for fuel. A C₃₋₄ fraction can be recycled upstream of the syngas
22 generation process by line 36, recycled to the Fischer-Tropsch unit by line 38,
23 or, alternatively, via line 39 it may be flared, used for fuel, transported in
24 pressurized tankers, and/or transported in refrigerated tankers.

25

26 Fischer-Tropsch Process Feedstocks

27

28 Natural gas which may be used to generate the synthesis gas used as a
29 feedstock in the Fischer-Tropsch process is an abundant fossil fuel resource.
30 Natural gas is often associated with petroleum production facilities. The
31 composition of natural gas at the wellhead varies, but the major hydrocarbon
32 present is methane. For example, the methane content of natural gas may

1 vary within the range of from about 40 volume percent to 95 volume percent.
2 Other constituents of natural gas may include ethane, propane, butanes,
3 pentane (and heavier hydrocarbons), hydrogen sulfide, carbon dioxide, helium
4 and nitrogen.

5

6 Since much of the known reserves for natural gas are found along with crude
7 oil in locations where it not economical to ship the gas to market, the natural
8 gas under such circumstances is often flared or re-injected into the well.

9 In either case, the economic value of the natural gas is lost. In addition, since
10 almost all of the carbon value in the natural gas is converted into products by
11 the Fischer-Tropsch process, minimal carbon dioxide is released into the
12 atmosphere.

13

14 Natural gas is classified as dry or wet depending upon the amount of
15 condensable hydrocarbons contained in it. Condensable hydrocarbons
16 generally comprise C₃ plus hydrocarbons although some ethane may be
17 included. Gas conditioning is required to alter the composition of wellhead
18 gas, processing facilities usually being located in or near the production fields.
19 Conventional processing of wellhead natural gas yields processed natural gas
20 containing at least a major amount of methane.

21

22 Typically, synthesis gas contains hydrogen and carbon monoxide, and may
23 include minor amounts of carbon dioxide and/or water. The presence of
24 certain contaminants, such as sulfur, nitrogen, halogen, selenium, phosphorus
25 and arsenic contaminants, in the syngas are undesirable. For this reason, it is
26 preferred to remove sulfur and other contaminants from the feed before
27 performing the Fischer-Tropsch chemistry. Means for removing these
28 contaminants are well known to those of skill in the art. For example,
29 ZnO guardbeds are preferred for removing sulfur impurities. Means for
30 removing other contaminants are well known to those of skill in the art.

1 It is also possible to use methane derived from other sources in the
2 Fischer-Tropsch process. Methane can be derived from a variety of other
3 sources, such as the fuel gas system, the gasification of the heavy
4 carbonaceous materials such as may be found in coal, coker bottoms, and
5 residuum, or even the reduction of methanol.

6
7 The synthesis gas used to carry out the present invention can be generated
8 using steam methane reforming, partial oxidation or gasification, or a
9 combined reforming or autothermal reforming process.

10 11 Fischer-Tropsch Synthesis

12
13 In the Fischer-Tropsch synthesis process, liquid and gaseous hydrocarbons
14 are formed by contacting a synthesis gas (syngas) comprising a mixture of
15 hydrogen and carbon monoxide with a Fischer-Tropsch catalyst under
16 suitable temperature and pressure reactive conditions. The Fischer-Tropsch
17 reaction is typically conducted at temperatures of from about 300 degrees to
18 about 700 degrees F (149 degrees to 371 degrees C), preferably from about
19 400 degrees to about 550 degrees F (204 degrees to 228 degrees C);
20 pressures of from about 10 to about 600 psia (0.7 to 41 bars), preferably 30 to
21 300 psia (2 to 21 bars); and catalyst space velocities of from about 100 to
22 about 10,000 cc/g/hr., preferably 300 to 3,000 cc/g/hr.

23
24 The products may range from C₁ to C₂₀₀ plus hydrocarbons with a majority in
25 the C₅ to C₁₀₀ plus range. The reaction can be conducted in a variety of
26 reactor types, for example, fixed bed reactors containing one or more catalyst
27 beds, slurry reactors, fluidized bed reactors, or a combination of different type
28 reactors. Such reaction processes and reactors are well known and
29 documented in the literature. Slurry Fischer-Tropsch processes, which is a
30 preferred process in the practice of the invention, utilize superior heat
31 (and mass) transfer characteristics for the strongly exothermic synthesis
32 reaction and are able to produce relatively high molecular weight, paraffinic

1 hydrocarbons when using a cobalt catalyst. In a slurry process, a syngas
2 comprising a mixture of hydrogen and carbon monoxide is bubbled up as a
3 third phase through a slurry in a reactor which comprises a particulate
4 Fischer-Tropsch type hydrocarbon synthesis catalyst dispersed and
5 suspended in a slurry liquid comprising hydrocarbon products of the
6 synthesis reaction which are liquid at the reaction conditions. The mole ratio
7 of the hydrogen to the carbon monoxide may broadly range from about
8 0.5 to about 4, but is more typically within the range of from about
9 0.7 to about 2.75 and preferably from about 0.7 to about 2.5. A particularly
10 preferred Fischer-Tropsch process is taught in EP0609079, also completely
11 incorporated herein by reference for all purposes.

12
13 Suitable Fischer-Tropsch catalysts comprise one or more Group VIII catalytic
14 metals such as Fe, Ni, Co, Ru and Re, with cobalt being preferred.
15 Additionally, a suitable catalyst may contain a promoter. Thus, a preferred
16 Fischer-Tropsch catalyst comprises effective amounts of cobalt and one or
17 more of Re, Ru, Pt, Fe, Ni, Th, Zr, Hf, U, Mg and La on a suitable inorganic
18 support material, preferably one which comprises one or more refractory
19 metal oxides. In general, the amount of cobalt present in the catalyst is
20 between about 1 and about 50 weight percent of the total catalyst
21 composition. The catalysts can also contain basic oxide promoters such as
22 ThO₂, La₂O₃, MgO, and TiO₂, promoters such as ZrO₂, noble metals
23 (Pt, Pd, Ru, Rh, Os, Ir), coinage metals (Cu, Ag, Au), and other transition
24 metals such as Fe, Mn, Ni, and Re. Suitable support materials include
25 alumina, silica, magnesia and titania or mixtures thereof. Preferred supports
26 for cobalt containing catalysts comprise alumina or titania. Useful catalysts
27 and their preparation are known and illustrated in U.S. Patent No. 4,568,663,
28 which is intended to be illustrative but non-limiting relative to catalyst
29 selection.

30
31 The products as they are recovered from the Fischer-Tropsch operation may
32 be divided into three fractions, a gaseous fraction consisting of very light

1 products, a condensate fraction generally boiling in the range of naphtha and
2 diesel, and a high boiling Fischer-Tropsch wax fraction which is normally solid
3 at ambient temperatures. In the present invention, the wax fraction is
4 recovered separately from the condensate/light product fraction and sent to
5 the thermal cracking unit. The condensate fraction is preferably separated
6 from the light product fraction prior to being blended back into the low pour
7 point wax product recovered from the thermal cracker. The light fraction may
8 be recycled to the Fischer-Tropsch reactor, used to fuel furnaces within the
9 facility, sold as heating fuel, or flared. If sufficient methane is present in the
10 light fraction to justify its separation from the C₂ to C₄ hydrocarbons, it may be
11 recycled to the reformer for conversion into syngas.

12

13 Thermal Cracking

14

15 The thermal cracking step employed in the process of the present invention is
16 intended to lower the pour point of the Fischer-Tropsch wax by cracking the
17 paraffin molecules into lower molecular weight olefins. At the same time, the
18 viscosity is also reduced. Although batch pyrolysis reactors such as employed
19 in delayed coking or in cyclic batch operations could be used to carry out this
20 step, generally a continuous flow-through operation is preferred in which the
21 feed is first preheated to a temperature sufficient to vaporize most or all of the
22 feed after which the vapor is passed through a tube or tubes. A desirable
23 option is to bleed any remaining nonvaporized hydrocarbons prior to entering
24 the tubes in the cracking furnace. Preferably, the thermal cracking is
25 conducted in the presence of steam which serves as a heat source and also
26 helps suppress coking in the reactor. Details of a typical steam thermal
27 cracking process may be found in U.S. Patent No. 4,042,488, hereby
28 incorporated by reference in its entirety. Although catalyst is generally not
29 used in carrying out the thermal cracking operation, it is possible to conduct
30 the operation in a fluidized bed in which the vaporized feed is contacted with
31 hot fluidized inert particles, such as fluidized particles of coke.

1 In the pyrolysis zone, the cracking conditions should be sufficient to provide a
2 cracking conversion of at least 10 percent by weight of the paraffins present.
3 Preferably, the cracking conversion will be at least 20 percent by weight, more
4 preferably at least 30 percent by weight, and most preferably at least
5 50 percent by weight. The term "cracking conversion" relates to the
6 percentage of the feed boiling above a reference temperature
7 (e.g., the initial boiling point) which is converted to products boiling below the
8 reference temperature. The optimal temperature and other conditions in the
9 pyrolysis zone for the cracking operation will vary somewhat depending on the
10 feed. In general, the temperature must be high enough to maintain the feed in
11 the vapor phase but not so high that the feed is overcracked, i.e., the
12 temperature and conditions should not be so severe that excessive C₄ minus
13 hydrocarbons are generated. The temperature in the pyrolysis zone normally
14 will be maintained at a temperature of between about 800 degrees F
15 (425 degrees C) and about 950 degrees F (510 degrees C). The optimal
16 temperature range for the pyrolysis zone will depend upon the endpoint of the
17 feed. In general, the higher the carbon number, the higher the temperature
18 required to achieve sufficient conversion to lower the pour point to an
19 acceptable level. Accordingly, some routine experimentation may be
20 necessary to identify the optimal cracking conditions for a specific feed. The
21 pyrolysis zone usually will employ pressures maintained between about
22 0 atmospheres and about 5 atmospheres, with pressures in the range of from
23 about 0 to about 2 atmospheres generally being preferred. Although the
24 optimal residence time of the wax fraction in the reactor will vary depending
25 on the temperature and pressure in the pyrolysis zone, typical residence times
26 are generally in the range of from about 1.5 seconds to about 500 seconds,
27 with the preferred range being between about 5 seconds and about
28 300 seconds.

29

30 In carrying out the process of the present invention, it is preferred that the
31 Fischer-Tropsch derived wax intermediate recovered from the thermal
32 cracking zone has a pour point of less than about 45 degrees F.

Fischer-Tropsch Derived Waxy Product

In its simplest embodiment, the Fischer-Tropsch derived waxy product is a blend of the Fischer-Tropsch derived wax intermediate recovered from the thermal cracking zone and the condensate recovered directly from the Fischer-Tropsch reactor. The Fischer-Tropsch derived waxy product should have a pour point below about 40 degrees C and preferably will have a pour point below about 20 degrees C. As already noted, the Fischer-Tropsch derived waxy product usually will have a significantly reduced viscosity as compared to the uncracked Fischer-Tropsch wax. In addition to the condensate, the blend usually will also contain C₅ to about C₁₉ hydrocarbons which are formed in the thermal cracking unit due to the cracking of the wax molecules. The various components are blended in the proper proportion to provide a product which may be pumped at ambient temperature and that will remain liquid during transportation. One skilled in the art will recognize that the proportion of each of the components will vary depending on such factors as the desired pour point of the Fischer-Tropsch derived waxy product, the pour point of the Fischer-Tropsch derived wax intermediate, the pour point of the condensate and the C₅ to about C₁₉ hydrocarbons, and the ambient temperature. Obviously, a pour point suitable for producing a pumpable Fischer-Tropsch derived waxy product in the tropics may not be satisfactory to produce a pumpable blend in the arctic. In order to lower the pour point, it may be necessary to increase the cracking conversion in the thermal cracking unit and/or increase the proportion of the lighter molecular weight hydrocarbons in the blend, i.e., the condensate and C₅ to about C₁₉ hydrocarbons.

The Fischer-Tropsch waxy product may also contain other materials so long as they do not raise the pour point above an acceptable level. For example, a conventional petroleum derived crude having a moderate pour point may be blended with the Fischer-Tropsch waxy product if so desired. Since Fischer-Tropsch units are often located in or near petroleum production

1 facilities, it may be desirable to transport a blend containing both the
2 Fischer-Tropsch waxy product and conventional crude.

3
4 The following examples are intended to illustrate the invention, but are not
5 intended to be interpreted as limitations on the invention.

6 7 EXAMPLES

8 9 Example 1

10
11 The thermal cracking pilot plant used in the following examples employed a
12 42 inch long tubular reactor, 0.75-inch OD, 0.56-inch ID containing 175cc of
13 12 mesh alundum. A commercial FT wax, C80 from Moore and Munger, Inc.
14 (Two Corporate Drive, Suite 434, Shelton, Connecticut 06484) having a pour
15 point of 82 degrees C and a viscosity at 100 degrees C of 8.445 cSt, was fed
16 to the reactor upflow at 2 LHSV, based on the alundum volume. Nitrogen gas
17 was also fed to the reactor at a rate of 500 SCF N₂/bbl wax feed. The total
18 pressure was 200 psig. The reactor temperature was 850 degrees F
19 (454 degrees C). The reactor effluent was stripped to remove C₄ minus gases,
20 and then distilled into C₅ to 650 degrees F and 650 degrees F plus fractions.

21
22 Blending the 650 degrees F minus and 650 degrees F plus fractions
23 recovered from the pilot plant yielded a whole thermal cracked C₅ plus product
24 with a pour point of 39 degrees C and a viscosity at 100 degrees C of
25 1.79 cSt. It will be noted that the thermal cracked C₅ plus product also had a
26 significantly reduced viscosity as compared to the original C80 FT wax.

Blending 50 weight percent of this C₅ plus thermal cracked product with 50 weight percent of a Fischer-Tropsch condensate having boiling range as shown in Table 1 yielded a C₅ plus product with a pour point of 13 degrees C (Blend No. 2 in Table 2).

Table 1

FT Condensate Properties	
API Gravity	56.6
D2287 Simulated Distillation	°F
0.5 wt%	76
5 wt%	193
10 wt%	243
30 wt%	339
50 wt%	415
70 wt%	494
90 wt%	569
95 wt%	595
99.5 wt%	661

Example 2

A blend of 50 weight percent C₈₀ Fischer-Tropsch wax (pour point 82 degrees C) plus 50 weight percent Arabian Medium crude oil (pour point -35 degrees C), identified as Blend No. 3 in Table 2, had a pour point of 62 degrees C which is generally too high to be transported by conventional means. A blend of 25 weight percent Fischer-Tropsch wax, 25 weight percent Fischer-Tropsch condensate, and 50 weight percent Arabian Medium crude (Blend No. 4 in Table 2) had a pour point of 53 degrees C which was still too high to be transported by conventional means.

Example 3

Another blend containing 25 weight percent thermal cracked wax, 25 weight percent Fischer-Tropsch condensate, and 50 weight percent Arabian Medium crude (Blend No. 5 in Table 2) was found to have a pour point of 9 degrees C.

1 This illustrates that blends within the scope of the invention may also include
 2 a conventional petroleum derived crude having a moderate pour point.
 3 Table 2 summarizes the pour points of these blends described in the above
 4 examples:

5
 6

Table 2

Blend	Wt% in Each Blend				Pour Pt, °C
	FT Wax C80	FT Condensate	TC Wax	Arabian Medium Crude	
	100				82
		100			-13
			100		39
				100	-35
1	50	50			62
2		50	50		13
3	50			50	62
4	25	25		50	53
5		25	25	50	9